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A Narrative Review: The Role of Electric Vehicles in Mitigating Carbon Emissions in the Philippines

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Abstract*—The global imperative to combat climate change and reduce reliance on fossil fuels has catalyzed the adoption of electric vehicles (EVs) as a sustainable transportation solution. This paper provides an in-depth analysis of the evolution, challenges, and policy interventions surrounding EV adoption, with a focus on the Philippines as a case study. Drawing from a diverse range of literature, it examines market dynamics, environmental impacts, energy consumption, and policy interventions related to EVs. Key findings reveal the positive correlation between EV adoption and CO2 emissions reduction, emphasizing the pivotal role of supportive policies and technological advancements in driving market expansion. Despite significant environmental benefits, challenges such as high battery costs, safety concerns, and charging infrastructure limitations underscore the need for a multifaceted approach. Ultimately, the paper advocates for an integrated approach that leverages technological innovation, policy reforms, and community engagement to realize the full potential of electric vehicles in achieving long-term sustainability goals. This study emphasizes the role of EVs in reducing carbon emissions, highlighting market dynamics and adoption rates, environmental impacts and challenges, energy consumption and emission reduction techniques, and policy interventions and government incentives as key aspects in shaping the future of sustainable transportation in the Philippines. Concluding with a set of recommendations that advocates for comprehensive measures involving policy adjustments, infrastructure improvements, public outreach, and strategies for environmental and economic sustainability to boost EV integration into public transportation systems.*

***Keywords*—** *Electric vehicles: CO emission mitigation: energy consumption: multifaceted impacts: chargeable vehicle.*

I. INTRODUCTION

Concerns about climate change and the 1973 Oil Crisis led to the development of modern electric vehicles (EVs) near the end of the 20th century according to the site found in https://blog.evbox.com/electric-cars-history. It is said that the rising oil costs and increasing carbon emissions are causing rise in the popularity of electric vehicles (EVs), which are independent of oil and do not emit toxic gases, and still some concerns are considered to be act (Alanazi F., 2023). Plug-in hybrid electric vehicles (PHEVs) is a special vehicle that uses both electricity and gasoline, a chargeable vehicle. This technology could boost the development of electric refueling stations, according to Dickerman, L. and Harrison, J. (2010). A smart grid (SG) can support the wider adoption of PHEVs by allowing them to be easily plugged into the electrical grid for recharging. PHEVs offer savings on fuel costs and operational benefits for utilities, but peak charging during peak times could increase operational costs. Therefore, developing an SG is crucial for managing charging times and rates.

Nevertheless, carbon emissions pose a considerable environmental challenge in the Philippines, stemming from various sectors such as transportation, energy production, industry, and agriculture. The country's heavy reliance on fossil fuels, coupled with rapid urbanization and industrial growth exacerbates the issue. In a 2019 report by the Philippine Statistics Authority (PSA), it was revealed that the energy industry emerges as the foremost source of carbon emissions, largely stemming from the combustion of fossil fuels for power production and transportation purposes.

The Philippines has initiated a substantial endeavor to substitute conventional gasoline-fueled tricycles with electric tricycles (E-Trikes) in urban regions to mitigate carbon emissions and improve air quality. This undertaking detailed in a 2015 report by the Asian Development Bank (ADB), has garnered financial support from global organizations such as the ADB and the United Nations Development Programme (UNDP). Simultaneously, electric jeepneys (E-Jeepneys) are being introduced to replace traditional diesel-powered jeepneys, a prevalent form of public transportation. Pilot initiatives and incentives facilitated by the Department of Energy (DOE) and local government bodies aim to encourage the adoption of E-Jeepneys, as highlighted in the Manila Bulletin.

Electric vehicles (EVs), fueled by sustainable energy sources, significantly contribute to reducing carbon emissions in contrast to traditional fossil fuel-driven vehicles. The Philippine government has been proactive in endorsing renewable energy endeavors by offering incentives and supporting policies. A research paper in Renewable and Sustainable Energy Reviews (2017), explored the feasibility of incorporating renewable energy to address carbon emissions from the transportation sector.

According to the news, the Philippines is eager to adapt electric vehicles (EVs) by investing in charging infrastructure through collaborations between public and private entities. In ABS-CBN News (2020) highlights the cooperation between local utility firms and private businesses to expand the EV charging network nationwide.

A piece by the Philippine Star in 2019 outlined strategic efforts by the Department of Trade and Industry (DTI) to offer financial incentives to EV manufacturers and component producers. Moreover, the Department of Energy (DOE) introduced the Electric Vehicle Roadmap in the same year to stimulate EV adoption, incorporating strategies such as

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incentives for both manufacturers and consumers. Furthermore, some governmental measures including tax incentives, have been instituted to promote the importation and local production of electric vehicles, as reported by ABS-CBN News.

This study provides an overview of the pivotal role of electric motors in reducing carbon emissions in the Philippines highlighting the primary aspects: market dynamics and adoption rates, environmental impacts and challenges, energy consumption and emission reduction techniques, and policy interventions and government incentives.

II. Market Dynamics and Adoption Rates

The dynamics and adoption rates of electric vehicles (EVs) across various countries present a fascinating study in the realm of sustainable transportation. In their analysis, Xiaolei Zhao et al. (2023) emphasize the positive impact of EV sales on reducing CO2 emissions in China. Their research highlights a direct link between increased EV adoption and a decrease in local emissions. Additionally, they underscore the role of renewable energy in enhancing these effects, suggesting a symbiotic relationship between EV market expansion and the development of sustainable energy sources.

Similarly, findings from Uy JRR et al. (2024) shed light on the challenges faced by consumers in the Philippines, particularly amidst rising inflation and electricity costs. The study underscores the pressing need for affordable EVs in the country. To address this need, the authors advocate for prioritizing advancements in battery technology by manufacturers. They also suggest collaboration with financial institutions to offer subsidies, incentives, or financing options, aiming to make EVs more accessible to consumers. Comparing these insights, we observe contrasting yet complementary narratives in the global landscape of EV adoption. While China showcases the positive environmental impact of EV proliferation, Norway and its neighboring countries demonstrate remarkable progress despite initial concerns about battery performance in cold climates. These contrasting experiences offer valuable lessons for policymakers and industry stakeholders worldwide.

The findings underscore the importance of multi-faceted approaches to promote EV adoption. Efforts to enhance battery technology, coupled with supportive policies and financial incentives, are crucial for overcoming barriers to EV ownership. Moreover, the integration of renewable energy sources further enhances the environmental benefits of EVs, creating a win-win scenario for sustainable transportation and climate action.

In Norway, despite of individual being worried that electric car batteries might not do well in the cold and might not go as far as gas cars. However, Norway and other nearby countries like Iceland and Sweden are ahead in using electric cars. The government kept encouraging electric cars because it provides better result and benefits for the environment. (https://www.wri.org/insights/countries-adopting-electric-vehicles-fastest)

III. Environmental Impacts and Challenges

Huo et al. (2010) report on China's promotion of EVs to meet rising energy demands while addressing the associated environmental challenges, such as increased SO2 and NOx emissions from coal-generated electricity. They call for urgent policy adjustments to mitigate these effects. Graeme Hill, Oliver Heidrich, and Felix Creutzig (2019) stress the critical role of EVs in decarbonizing transport but also underscore the importance of adopting complementary strategies like enhanced public transit and carpooling to achieve emission reduction targets effectively.

On the other hand, Graeme Hill, Oliver Heidrich, and Felix Creutzig (2019) highlight how essential EVs are to the transportation sector's decarbonization. They do, however, issue a warning that EV adoption alone might not be adequate to successfully fulfill emission reduction objectives. Rather, they support the use of complementing tactics like enhancing the infrastructure of public transportation and promoting carpooling.

According to Moro, A. et. al (2018), Holmberg, K. and Erdemir, A. (2019), and Weber, N.D.A.B. et. al (2019), reaffirms the existing evidence that electric vehicles in the Philippines emit fewer greenhouse gases than internal combustion engines, aligning with the broader consensus on their environmental benefits. Such findings underscore the importance of transitioning to electric vehicles as a key strategy for reducing carbon emissions and mitigating climate change. As society continues to prioritize sustainability, the promotion and adoption of electric vehicles are crucial steps towards achieving long-term environmental goals.

IV. Energy Consumption and Emission Reduction Techniques

An article from the UPLB Journal (2023) outlines strategies for reducing carbon emissions through energy-saving techniques and adopting lower-emission energy sources. This approach focuses on conservation and transitioning to cleaner energy alternatives as essential steps towards reducing the carbon footprint. Altogether, these sources provide a comprehensive overview of the current state and future directions for electric vehicles and energy-efficient technologies, reflecting a blend of challenges and opportunities across policy frameworks, market conditions, and environmental considerations.

V. Policy Interventions and Government Incentives

Agaton et al. (2019) emphasize the urgent need for government support in adopting e-jeepneys in the Philippines through increased subsidies, the development of public charging infrastructure, and a shift to cleaner energy sources to encourage transport operators towards electrification. De Almeida, Ferreira, and Fong J (2023) discuss the necessity of promoting energy-efficient electric motors in Europe, noting the low replacement rate of old inefficient motors. They advocate for innovative policies to expedite progress toward climate targets.

The series of studies highlighted in the text explores various

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environmental, economic, and technical aspects of adopting cleaner transportation and energy-efficient technologies. Agaton CB and colleagues (2019) focus on the trade-offs involved in replacing diesel jeepneys with electric alternatives in the Philippines, discussing not only the potential health benefits but also the challenges related to costs, safety, reliability, and infrastructure. They suggest considering other eco-friendly options like biofuels and hybrids as part of a broader strategy for sustainable public transportation.

Overall, the collection of research underscores the necessity of innovative and integrated approaches in energy and transportation policies to achieve substantial and sustainable reductions in greenhouse gas emissions and other pollutants. The research examines the impact of investing in public transportation, highlighting the benefits of electric vehicles but also highlighting concerns like high battery costs, safety, and charging infrastructure. It suggests alternatives like biofuel and hybrid vehicles. The study emphasizes the need for integrating EVs with policies and technological upgrades to reduce emissions and environmental impacts. It also emphasizes the importance of energy-efficient lighting and power management in mining projects.

VI. Conclusion

The research explores the role of electric vehicles (EVs) in the Philippines, focusing on the paper objectives; market dynamics and adoption rates, environmental impacts and challenges, energy consumption and emission reduction techniques, policy interventions and government incentives. It highlights the benefits of EVs (electric vehicles) especially in mitigating CO2 emissions, but also raises concerns about battery costs, safety, and charging infrastructure. Alternatives like biofuel and hybrid vehicles are suggested. The study emphasizes the need for integrating EVs with policies and technological upgrades to reduce emissions and environmental impacts. Policy interventions and incentives play a crucial role in driving adoption but require careful navigation of trade-offs.

Ultimately, achieving sustainable transportation hinges on an integrated approach that embraces technological innovation, policy reforms, and societal shifts toward greener practices.

VII. Recommendation

These suggestions offer a variety of measures to enhance public transportation in switching to electric vehicles, researching biofuel and hybrid possibilities. Key points include the following:

1. Government Policies: It advocate for tax incentives, subsidies, and financing for electric car infrastructure.
2. Economic Analysis: Conducting cost-benefit analysis to evaluate various vehicle types and investigating new funding options.
3. Technological Development: Investing in improving battery technology and investigating biofuel alternatives.
4. Infrastructure Improvements: Choosing strategic charging station sites and ensuring that the electrical infrastructure can handle growing electric car use.
5. Environmental and Health Impact Studies: Modeling emission changes and investigating the possible health benefits of decreased pollution.
6. Public Engagement: Conducting educational programs and soliciting community comments to boost support for new technology.
7. Progress Monitoring: Setting and evaluating key performance indicators and maintaining open feedback channels to improve services.
8. Urban Planning Integration: Ensuring that new transportation plans align with broader city development strategies.

These steps are designed to help policymakers and urban planners facilitate a smoother transition to more sustainable public transportation options.

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